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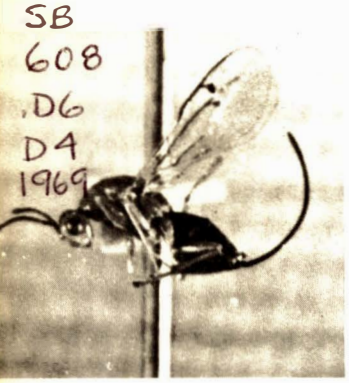

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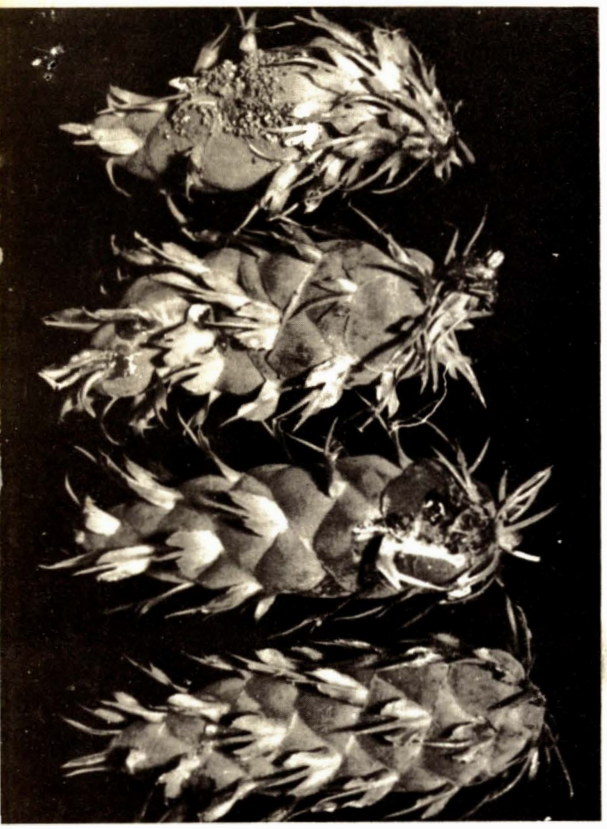

RESULTS OF A DOUGLAS - FIR CONE AND SEED INSECT STUDY IN MONTANA AND YELLOWSTONE NATIONAL PARK 1968

U. S. DEPARTMENT OF AGRICULTURE – FOREST SERVICE
DIVISION OF STATE AND PRIVATE FORESTRY
NORTHERN REGION

MISSOULA, MONTANA
5200(3000)

RESULTS OF A DOUGLAS-FIR CONE AND SEED INSECT STUDY IN MONTANA AND YELLOWSTONE NATIONAL PARK 1968

By

Jerald E. Dewey, Entomologist
Forest Insect and Disease Branch

SUMMARY

Sixty-two percent of the 10,800 Douglas-fir cones collected in Montana and Yellowstone National Park, Wyoming, were visibly deformed by insect feeding in 1968. Of the 11 species of insects found feeding on cones, the spruce budworm, Choristoneura fumiferana (Clemens), was the most injurious. Considerable damage was also caused by the Douglas-fir scale midge, Contarinia washingtonensis Johnson, and the fir cone worm, Dioryctria abietivorella (Grote). Nineteen species of insects that were parasitic or predatory on the cone feeders were reared to adults. Insects were sent to the National Museum for identification. The cone crop was very light at all plots except No. 13 during 1968.

INTRODUCTION

Much of Montana's Douglas-fir type suffers from unsatisfactory regeneration. Forest managers believe that insects are partially responsible for this. In 1967, a study was initiated in eastern Montana and Yellowstone National Park on cone and seed insects of Douglas-fir (Dewey and Honing 1967)1/ with the objective of determining their role on regeneration. About 30,000 Douglas-fir cones were collected between late May and the end of September 1967. Half of these were dissected to determine injury and the remainder placed in rearing containers to obtain adult insects. Twenty-seven species of insects were recovered from the cones; 12 were cone or seed feeders, 12 were parasites of the cone feeders, and the role of 3 species is unknown. In 1968 the study was continued in the same areas and expanded to include four additional sites in western Montana (fig. 1).

1/ Dewey, Jerald E. and Frederick W. Honing. A study of insects attacking Douglas-fir cones in eastern Montana and Yellowstone National Park, 1967. Unpub. report, 15 pp., U.S. For. Serv. July 1968.

The Douglas-fir cone crop fluctuates greatly. Good crops are borne about every 3 to 7 years, with light crops in between. The 1967 crop was heavy in all areas sampled, but very light in all areas except plot 13 in 1968.

METHODS AND PROCEDURES

SAMPLING

The nine plots sampled in 1967 were sampled three times in 1968--mid-June, late July, and late August; whereas the new plots were sampled four times--near mid-June, July, August, and September.

Because insect population differences were so slight among crown levels in 1967, and due to the scarcity of cones, no attempt was made to collect cones from specific crown levels in 1968.

A sample was to consist of 300 cones per plot for each collection, for a total of 12,900 cones in 1968, but because of the light cone crop, complete samples were not always possible. A total of 10,800 cones were actually collected.

EXAMINATION OF CONES AND REARING OF INSECTS

Two hundred and twenty-five cones from each plot were dissected from each collection in the laboratory. Cones were cut lengthwise with a cone cutter, and individual scales were removed and examined. Insects that were uninjured, after dissections, were placed in Petri dishes with cones and artificial media for rearing (fig. 2). The remaining cones were placed in two-quart jars with screen lids to recover emerging adult insects.

In early July, 50 infested cones and branches were placed in Randall cages (figs. 3 and 4) to collect adult insects as they emerged. This permitted the branch to be kept in a water tray to keep the twig and cone green.

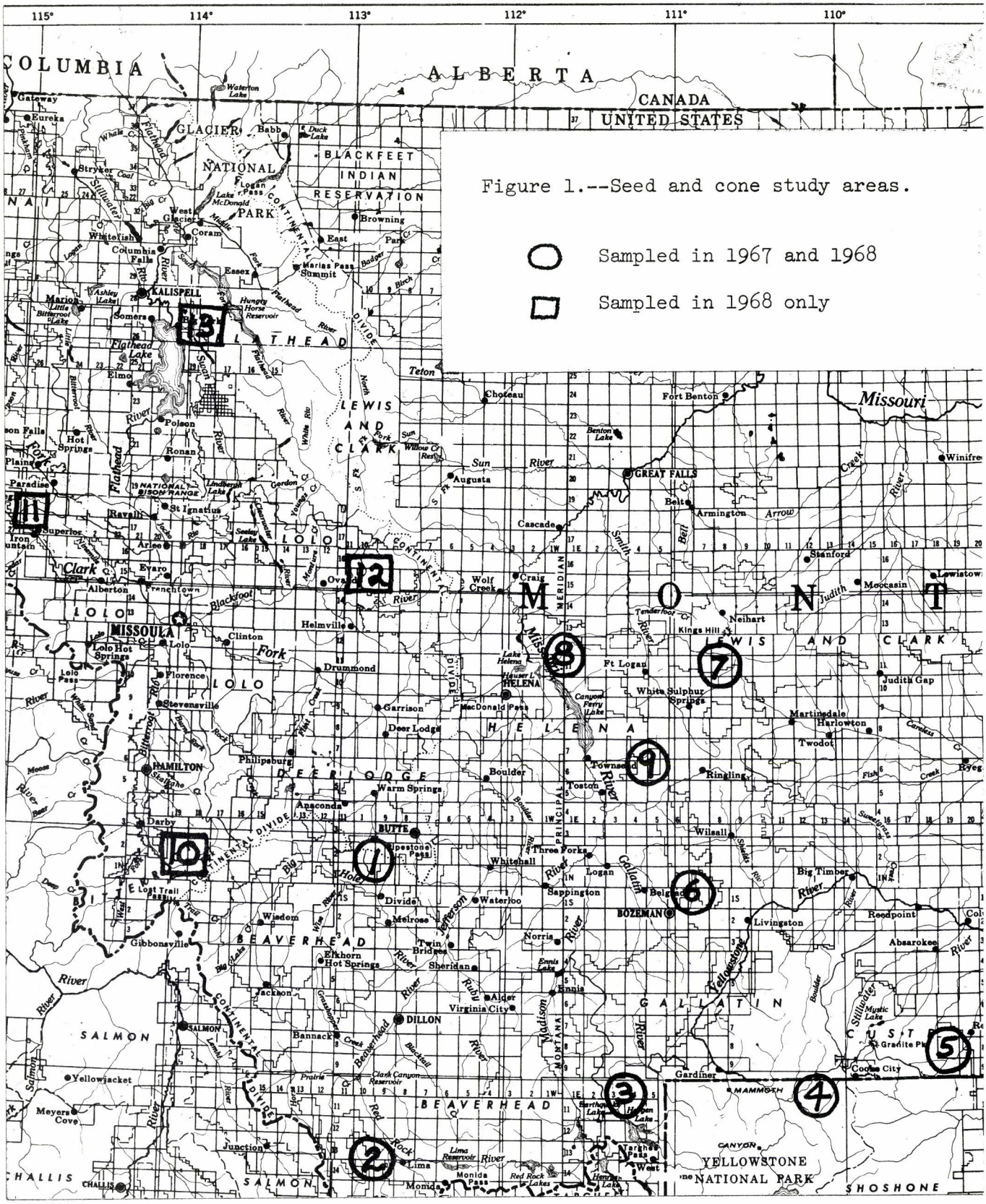
115°
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Figure 1.--Seed and cone study areas.
Sampled in 1967 and 1968
Sampled in 1968 only
GLACIER NATIONAL PARK
BLACKFEET INDIAN RESERVATION
FLATHEAD
LEWIS AND CLARK
LOLO
DEER LODGE
HELENA
BEAVERHEAD
GALLATIN
MADISON
SALMON
CUSTER
MONTANA
Missouri
Flathead River
Flathead Lake
Bitterroot River
Clark Fork
Blackfoot River
Big Hole River
Jefferson River
Madison River
Gallatin River
Yellowstone River
Sun River
Missouri River
Smith River
Judith River
Musselshell River
Stillwater River
Whitefish
Columbia Falls
KALISPELL
Somers
Polson
Ronan
St. Ignatius
Ravalli
Arlee
Evaro
Alberton
Frenchtown
MISSOULA
Clinton
Lolo
Lolo Hot Springs
Florence
Stevensville
Hamilton
Darby
Lost Trail Pass
Gibbonsville
Wisdom
Elkhorn Hot Springs
Jackson
Salmon
Yellowjacket
Meyers Cove
Challis
Junction
Lima
Monida
Red Rock Lakes
Monida Pass
Lima Reservoir
Dillon
Bannack
Virginia City
Alder
Ennis
Sheridan
Twin Bridges
Melrose
Divide
Waterloo
Whitehall
Three Forks
Sappington
Logan
Belgrade
BOZEMAN
Livingston
Gardiner
MAMMOTH
Cooke City
Absarokee
Reedpoint
Big Timber
Wilsall
Ringling
Martinsdale
Harlowton
Twodot
Judith Gap
White Sulphur Springs
Neihart
Kings Hill
Belt
Armington
Great Falls
Fort Benton
Choteau
Augusta
Cascade
Craig
Wolf Creek
Helena
Lake Helena
Hauser L.
MacDonald Pass
Canyon Ferry Lake
Townsend
Toston
Boulder
Deer Lodge
Garrison
Drummond
Philipsburg
Anaconda
Warm Springs
Butte
Pipestone Pass
Helmville
Ovando
Seeley Lake
Lindbergh Lake
Hungry Horse Reservoir
Marias Pass Summit
Essex
Browning
East Glacier
West Glacier
Coram
Babb
Waterton Lake
Duck Lake
Lake McDonald
Logan Pass
Stryker
Eureka
Gateway
Marion
Somers
Elmo
Hot Springs
Paradise
Superior
Arlee
Clinton
Lolo Pass
Stevensville
Darby

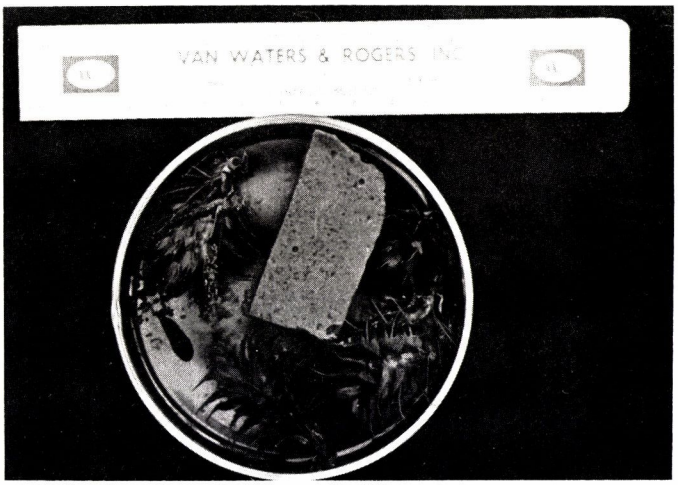

Figure 2.--Rearing insects in Petri dishes.

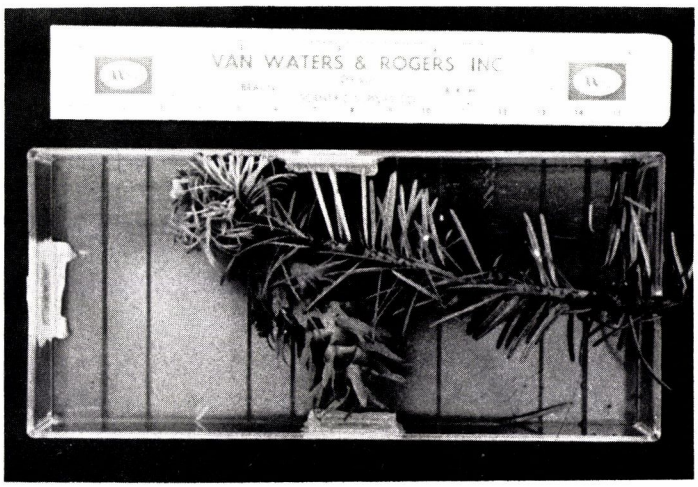

Figure 3.--Randall rearing cage with cone.

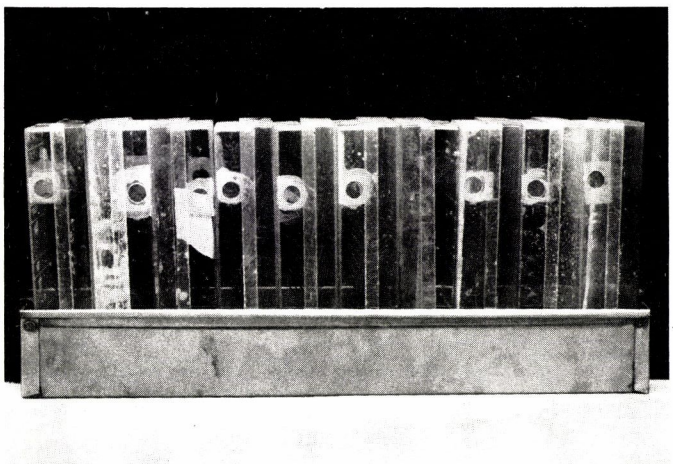

Figure 4.--Tray of Randall cages.

RESULTS

INSECTS PRESENT

Twenty-seven species of insects were reared from cones in 1967, and 30 species in 1968. Eight species of insects reared in 1967 were not collected in 1968, and 11 species reared in 1968 did not occur in 1967. Pooling the 2 years' data, 38 species of insects have been collected from the study areas. Thirteen of these were cone and seed feeders, 22 were parasites and predators of the cone feeders, and the role of 3 species is unknown (table 1).

ANALYSIS OF INJURY

Cones showing insect feeding, frass, or excess resin exudations were recorded as deformed prior to dissections. In 1968, 62 percent of the cones were deformed, compared to 48 percent deformed in 1967. All insects within the cones were counted and separated into taxonomic groups (table 2).

Five species of lepidopterous larvae were reared from cones in the study area in 1968. Because it is impossible to differentiate between these insects in the early instars, all lepidopterous larvae were lumped in the first collection. By the second collection most of the spruce budworm larvae had pupated and left the cones. The exact number of budworm present and amount of injury caused by the insect could not be determined. In 1967, samples were collected every 3 weeks instead of every 6 weeks as in 1968, allowing a collection while the budworm were well developed late instars that were readily identified. However, from the characteristic budworm injury, it was apparent spruce budworm was the most destructive insect in the study area during 1968.

Cones begin developing before lateral and terminal buds break, making the young, tender conelet a good food source to newly emerged second and third instar budworm. Many developing conelets attacked by budworm in early June shrivel and die (fig. 5), giving the appearance of frost damage or nonpollination. Close examination shows budworm feeding injury, often at the very base of the conelet. Budworm continue to feed on cones until pupation, usually in mid-July, at which time the cone is becoming woody. An individual budworm may feed on several cones during its development.

The Douglas-fir scale midge was the most common insect encountered in 1967 and 1968. However, due to its size and feeding habits several midges are needed to inflict as much damage as one budworm or fir cone worm. In 1968, midges were collected from 11 of the 13 collecting sites and infested from 3 to 70 percent of the cones from these sites. There were from 1 to 47, with an average of 10 midges per infested cone.

Table 1.--Classification of insects reared from Douglas-fir cones[1/]

Cone feeders	Parasites and predators	Miscellaneous cone associated insects
LEPIDOPTERA:	HYMENOPTERA:	DIPTERA:
Tortricidae:	Pteromalidae:	Cecidomyiidae:
Choristoneura fumiferana[2/]	*Zacalochlora milleri* Crawford[3/]	*Asynapta keeni* (Foote)[2/]
Gelechiidae:	Eulophidae:	COLEOPTERA:
Chionodes sp.[3/]	*Tetrastichus strobilus* Burks[2/]	Lathridiidae:
Filatima sp.[3/]	Braconidae:	*Lathridius minutus* (Linnaeus)[3/]
Olethreutidae:	*Apanteles fumiferana* Viereck[2/]	*Corticaria* sp.[2/]
Griselda radicana (Walsingham)[2/]	*Bracon* sp.[3/]	
Barbara colfaxiana (Kearfoot)[2/]	*Apanteles petrovae* Walley[4/]	
Pyralidae:	*Apanteles starki* Mason[4/]	
Dioryctria abietivorella[2/]	*Bracon cushmani* (Muesebeck)[4/]	
Dioryctria pseudotsugella Munroe[4/]	Ichneumonidae:	
DIPTERA:	*Campoplex* sp.[3/]	
Cecidomyiidae:	*Exeristes comstockii* (Cresson)[2/]	
Contarinia washingtonensis[2/]	*Phaeogenes* sp.[2/]	
Lonchaeidae:	*Glypta fumiferana* (Viereck)[2/]	
Earomyia barbara McAlpine[2/]	*Ichneumon* sp.[3/]	
HYMENOPTERA:	*Scambus*, probably new species[4/]	
Torymidae:	*Exochus turgidus* Holmgren[4/]	
Megastigmus spermotrophus Wachtl[2/]	*Campoplex conocola* (Rohwer)[4/]	
HOMOPTERA:	Torymidae:	
Aphidae:	*Torymus* sp.[3/]	
Chermes cooleyi (Gillette)[2/]	*Roptrocerus xylophagorum* (Ratzeburg)[4/]	
THYSANOPTERA:	Eurytomidae:	
Thripidae:	*Eurytoma* sp.[2/]	
Oxythrips sp.[2/]	Platygasteridae:	
Frankliniella sp.[2/]	*Leptasis* sp.[4/]	
	DIPTERA:	
	Tachinidae:	
	Actia sp.[2/]	
	COLEOPTERA:	
	Cleridae:	
	Phyllobaenus sp., possibly *subfasciata* (LeConte)[4/]	
	HEMIPTERA:	
	Miridae:	
	Deraeocoris rufusculus Knight[4/]	

1/ Insects were sent to the National Museum for identification. The Cecidomyiidae larvae were sent to Dr. N. E. Johnson, Department of Entomology, Cornell University. The Pyralidae adults were sent to Dr. W. H. Lange, Department of Entomology, University of California in 1967 and to Dr. Akira Mutuura, Entomology Research Institute, Ottawa, Ontario, Canada in 1968. The Lonchaeidae adults were identified by Dr. J. F. McAlpine, Entomology Division, Ottawa, Ontario, Canada.

2/ Reared in both 1967 and 1968.

3/ Reared in 1967 only.

4/ Reared in 1968 only.

Table 2.--Percent of cones infested by plots, 1968

Plot number	Percentages			
	Visibly deformed cones	Spruce budworm and miscellaneous lepidoptera	Midges	Other
1	52	4.4	6.7	0.4
2	44	1.8	--	--
3	37	8.9	--	7.1
4	43	9.8	11.1	1.8
5	28	9.3	52.9	36.0
6	38	3.1	7.6	.9
7	49	20.4	16.0	5.8
8	87	48.4	7.1	8.9
9	97	33.3	3.1	1.3
10	81	40.4	5.3	.4
11	88	52.9	70.7	5.8
12	98	54.2	9.8	9.8
13	70	8.0	25.8	.9
Average	62	22.7	16.6	6.1

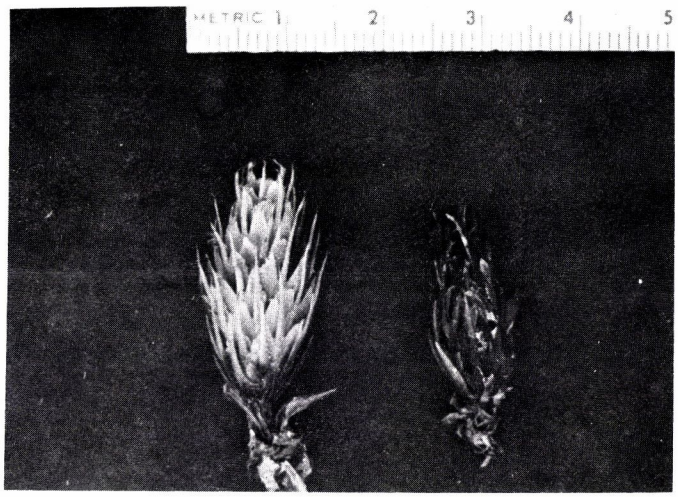

Figure 5.--Normal and budworm attacked conelets. Note entrance hole in injured conelet.

Midges do not destroy cones during their feeding but do greatly reduce viability of the seeds (Johnson 1963).2/

The Douglas-fir cone worm (fig. 6) was a serious cone feeder in 1968, but unimportant in 1967. Feeding habits of this insect are similar to

2/ Johnson, N. E. Cone scale necrosis and seed damage associated with attacks by Douglas-fir cone midges. For. Sci. 4(1): 44-51. 1963.

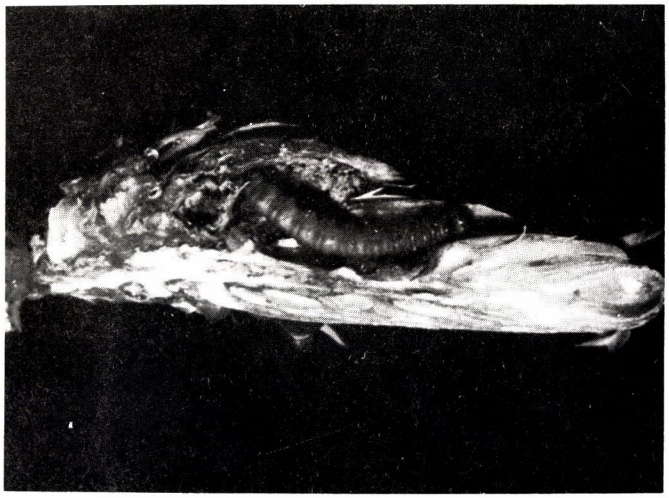

Figure 6.--Douglas-fir cone worm.

those of the budworm, though not as damaging. Two or more cone worms may share the same cone. Exact percentages of infested cones were not available in 1968.

Other lepidopterous cone feeders reared in 1968 were Barbara colfaxiana and Griselda radicana. Neither occurred in great enough numbers to be of any real significance.

Other less important cone feeding insects collected were the fir seed maggot, Douglas-fir seed chalcid, aphids and thrips.

DISCUSSION

Although the spruce budworm has never been recorded as a major pest of Douglas-fir cones, damage had been observed in the past by Region 1 entomologists (Scott 1969).3/ It is assumed, therefore, their importance as cone feeders has been overlooked.

Light to moderate spruce budworm defoliation was apparent from aerial surveys in four of the study areas (8, 9, 11, 12) in 1968. These four averaged 92 percent deformed cones. The remaining nine, where budworm defoliation was too light to detect aerially, averaged only 49 percent of the cones deformed. In two heavily defoliated areas, separate from the study plots, almost 100 percent of the cones were injured or destroyed. This suggests a strong correlation between budworm numbers and cone loss.

3/ Scott, D. O. Personal communications. 1969.

Survey records show that spruce budworm populations reached epidemic levels on the east side forests in 1947 and remained high except for local areas until 1964. From then until the present, budworm populations have declined to low levels in most of these areas. If budworm is as damaging in cones as 2 years' data indicate, this insect could be responsible for much of the poor regeneration on the east side forests where it was at or near epidemic levels for 17 consecutive years.

Budworm populations reached epidemic conditions on forests in western Montana and northern Idaho in 1957. These populations have fluctuated considerably due to applied control and natural factors; but if the populations were to persist at high levels for several years, natural regeneration may be reduced in these areas. Budworm effect on regeneration is another value to consider along with tree mortality and growth reduction in deciding for or against applied control.

Johnson (1963) has found that less than 1 percent of the seed from cones heavily infested with the Douglas-fir scale midge was viable. Gashwiler (1967)[4/] showed that 88 percent of the Douglas-fir seed that reached the ground was destroyed by birds, small mammals, and other agents before germination.

The complete role of insects on Douglas-fir regeneration is unknown. From the past 2 years' study some has been learned but several more years' data will be needed to understand the entire relationship. It would appear to be unprofitable to collect seed from areas heavily infested with spruce budworm or Douglas-fir scale midges. Little natural Douglas-fir regeneration can be expected during years of high populations of these insects.

4/ Gashwiler, J. S. Conifer seed survival in a western Oregon clearcut. Ecology 48(3): 431-438.